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THE RÔLE OF PHYSIOGRAPHY IN MILITARY OPERATIONS[1]

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INTRODUCTION

STUDY of the terrain is an essential preparation for military operations. Under terrain, students of military science include all the features of the land surface, whether natural or artificial, which affect the movements and disposition of troops either on the offensive or defensive. The relative importance of the terrain in a military problem varies obviously with respect to other factors, such as the strength, disposition, and morale of both enemy, and friendly troops, and the proportion of infantry to the other arms present. It may be safely assumed that the terrain will enter into the solution of nearly every military problem. The features of the land surface under various names, such as topography and land form, are the principal study of the modern school of physiographers and geographers. Physiographers are concerned with the origin of the topography of the earth's surface; geographers with the relation of this topography to the habits and character of man. The methods and results of these scientific inquiries into the nature of topography may, however, be readily adapted to the needs of military operations. This relation between physiographic and military science was first recognized by the French, though their use of physiographic material in the late war was subconscious rather than conscious.[2]

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[1] Published by permission of the Director of the United States Geological Survey.

[2] Brooks, Alfred H., "The Use of Geology on the Western Front," U. S. Geol. Survey, Contrib. to General Geol. Prof. Paper. In press.

Marga, A., "Géographie Militaire," 5 vols. and atlas, Paris. 1884–1885.

Where operations are on a large scale, neither the responsible general officers nor line officers have sufficient time or opportunity for detailed study and analysis of the terrain. They must rely for information on the maps and reports of others. The preparation of these reports, in so far as they pertain to terrain only, can best be done by geologists trained in physiography. The same methods and observations which they are accustomed to make for scientific studies serve equally well for military purposes.

The preceding generalizations have resulted from my service in the late war, and the following paper divides naturally into two parts: (1) a personal account of the use of physiography in actual operations; (2) suggestions for the application of physiographic information and for the utilization of geologists in the future.

The preparation of the paper has been greatly facilitated by the generous and constructive criticism of Mr. A. H. Brooks, formerly Lieutenant Colonel, Engineers, and chief geologist, A. E. F., Major Lawrence Martin, G. S., Lieutenant Colonel A. M. Prentiss, C. W. S., and Messrs. N. C. Grover, H. G. Ferguson, Sidney Paige and John S. Brown.

EXPERIMENTS IN THE USE OF PHYSIOGRAPHY

Organization of the 5th Army Corps

Through the operations of the Selective Draft, I found myself on June 30, 1918, a private in Headquarters Detachment of the 5th Army Corps. An army corps is the administrative unit which supervises three or more divisions and is, in turn, subordinate to the army. The newly organized 5th Corps had headquarters at this time in Remiremont, Vosges, and the commanding general had administrative but not tactical control of two divisions which were in training under a French Corps commander on the Alsace Front. The headquarters staff was divided into three sections, of which the second, known as the Intelligence Section, or simply G–2, had to do with information regarding the enemy, morale behind the lines, and counter espionage. Colonel George M. Russell, a regular army officer, was in command of this section of the Staff consisting of 12 officers and 59 enlisted men. Maps, map-making, and drafting for the corps were handled by a subdivision of G–2 called the Topographical Section, or G–2–C, in which I was enrolled as a

Barré, O., " Cours de Géographie, and Croquis Geographique, l'école d'application de l'artillerie et du genie," Fontainebleau, 1897–1900.

draftsman. Lieutenant Reuben A. Kiger, a topographical engineer of much experience on the United States Geological Survey, was in charge, and later he was assisted by Lieutenant R. B. Holmes.

My time for the first month was occupied in improving my technique in drafting and in learning the routine of Corps procedure. The officers of the Corps were also engaged in adjusting themselves to their new duties and not the least of their problems was to learn the use of maps. Largely recent civilians, lawyers, business men and engineers, they had paid little attention during their early education to topography and maps. Their army training was so brief and crowded that these studies had seemed less important than infantry drill and army paper work. Colonel Russell with his West Point training and Lieutenant Kiger and Lieutenant Holmes with experience on the Geological Survey were quite exceptional in starting in on Corps duties with an adequate knowledge of maps. While frankness compels us to admit this serious deficiency, one should bear in mind the remarkable achievements of this organization. The French consider that the building up of a Corps Staff is a matter of years yet the 5th Corps within two months of its organization began the successful St. Mihiel drive and two weeks later formed the center of the line in the Argonne in one of the most stubbornly fought engagements in history.

At the close of the St. Mihiel drive, the Corps had settled down in its routine work and a very keen appreciation of the value and use of maps had arisen. The Topographic Section was now called on for maps of many different scales and for many different purposes.

Block Diagram of the Argonne Region

The first rush of the Argonne offensive, beginning September 26, was remarkably successful. But because of increasing resistance and our inability to bring forward artillery fast enough, we were hung up before Cierges from September 28 to October 4. Again from October 5 to 8 we were stalled near Gesnes, by the outpost defenses of the Kriemhilde Stellung. The First and Third Corps on either side were in similar difficulties.

Many of our troubles arose from lack of appreciation of the terrain. Around Corps Headquarters many officers did not seem to have an adequate conception of the country in which the Corps was fighting, nor its relation to contiguous territory.

This impression, based on the gossip of Headquarters available to enlisted men, seemed to reflect a state of mind prevalent throughout the whole organization. Divisions and smaller units had of course even less information than we had, but had the advantage of seeing the country immediately in front of them. Lack of appreciation of topography was general and, while excusable, a condition which could be easily remedied.

A number of our officers had read D. W. Johnson's book on "Topography and Strategy of the War" and they testified that it had given them an invaluable conception of the topography of the theater of war in France. I could not, of course, judge of the correctness of Johnson's views on strategy, but his method of presentation is excellent. His topographic description is based on the best physiographic information and is built around and constantly refers to a simple block diagram of eastern France. Accordingly, I began work during time free from other duties, on a block diagram of the Argonne Region, similar in style to Johnson's diagram of eastern France.

The diagram is reproduced in Fig. 1, having been redrawn and slightly modified to conform with the detailed geologic maps now available. At the time, the only source of information was a school atlas of France. The text, reproduced below, has also been altered to conform more nearly to my present conception of what such a topographic description should be. The diagram and text are, however, essentially the same as when they were issued as a supplement to the Corps Summary of Intelligence. It will be noted that there is no discussion of strategy or tactics, which are not considered to be within the province of the Intelligence Section.

MILITARY TOPOGRAPHY OF THE ARGONNE REGION

The Argonne Region as a field for military operations has certain striking topographic features. The Argonne and adjacent territory from our front line northward consists of six distinct belts of country. As shown in the block diagram attached, these regions, beginning at the west, are: (1) Escarpment of the Dry Champagne (Champagne Pouilleuse), the crenulated edge of a plateau; (2) Aisne Valley (Champagne Humide), a lowland; (3) Forêt d'Argonne, a rugged ridge; (4) Aire Valley, a flat-bottomed valley with rolling country on the east; (5) Côte de Meuse, a deeply incised plateau; (6) Wovere Plain, a lowland. The topography of each of these regions is carved from the underlying rocks which form the rim of the Paris Basin. These rocks are great sheets of limestone and shale which dip gently beneath the ground to the west and southwest like the edges of a nest of saucers with Paris in the center. Each bed of limestone forms a ridge with an abrupt slope on the east, and a gentle westward slope. The shales form lowlands between the ridges. The ridges thus formed are: (1) Escarpment of the Dry Champagne; (2) Forêt d'Argonne; (3) Côte de Meuse.

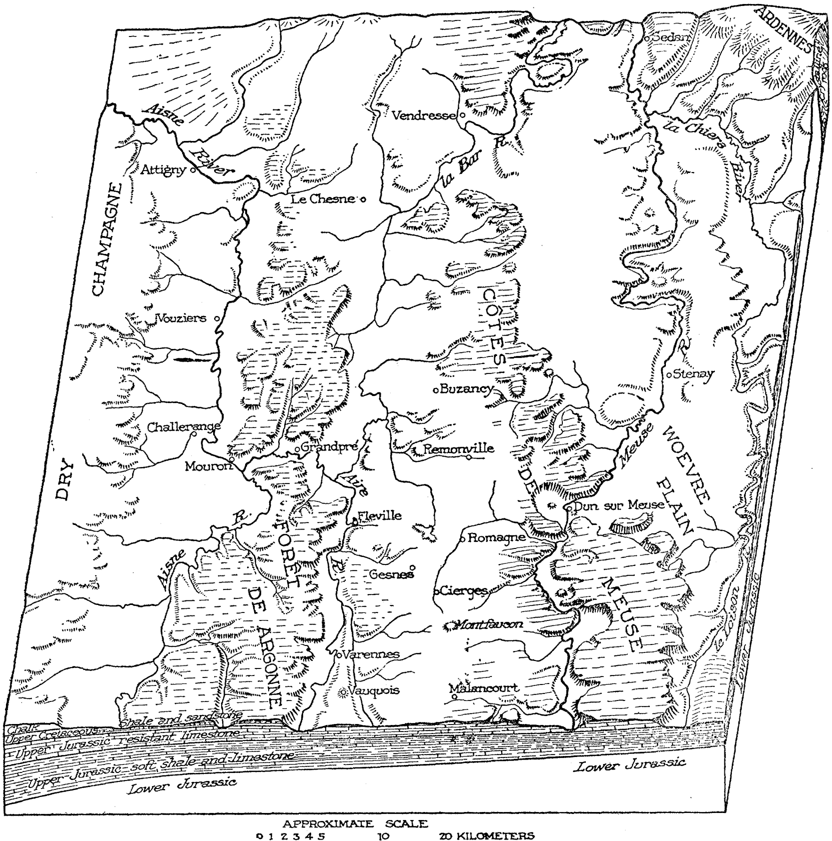

FIG. 1. BLOCK DIAGRAM SHOWING THE RELATION OF TOPOGRAPHY TO GEOLOGY AND TO MILITARY OPERATIONS IN THE ARGONNE REGION.

The Escarpment of the Dry Champagne is about 60 meters high, and is in many places cleared and cultivated, yet the branching ravines which indent the border of the escarpment and drain eastward to Aisne River afford excellent cover for artillery. The rough country yields many places suitable for local strong points. The effectiveness of this topography for defensive operations is shown in the recent resistance of the enemy on the line Monthois-Livry-Orfeull, west of Challerange.

The Forêt d'Argonne ridge rises 100 meters above the adjacent valley of the Aisne. It is much higher and more rugged than the Escarpment of the Dry Champagne. The scanty soil and steep slopes have led to its being used almost exclusively as timber land and there are few clearings and few roads. The ridge is divided by the valley of the Aire River at Grandpré. North of this gap it is not so bold or conspicuous and gradually fades out into isolated wooded hills in the vicinity of Attigny.

The Côte de Meuse lies parallel to the Forêt d'Argonne at a distance of 25 to 30 kilometers. The eastern border of this plateau is a particularly bold escarpment rising about 250 meters above the Woevre Plain. Against the eastern face of the plateau the waves of the German advance broke in 1914. The canyon of the Meuse River divides the ridge diagonally between Verdun and Dun-sur-Meuse. The serpentine bends of this flat-floored canyon prohibit its use as a ready means of advance across the ridge, yet the sharp bends and projecting spurs prevent long-range observation and render sections of the canyon, once occupied, of great value for the location of supply lines. The tributaries of the Meuse entering from east and west have cut sharp ravines in both walls of the canyon and converted the plateau into a succession of cross-ridges. Over these ridges and astride the river the Crown Prince advanced in his assault on Verdun. In turn, over the same successive ridges, the Allies are now advancing northward. The advantage of topography is, however, with the Allies, for the Côte de Meuse decreases in height toward the north and fades out into isolated hills and ridges at la Bar River.

The lowlands of the regions are: (1) The Aisne Valley; (2) The Aire Valley (from Varennes to Buzancy); (3) The Woevre Plain.

The Aisne Valley, or more properly the Valley of the Upper Aisne, is the northern representative of the Wet Champagne. The soil is clayey and tends to be boggy in wet weather.

The district from Varennes to Buzancy may be considered as a lower belt of country between the Forêt d'Argonne and the Côte de Meuse, or as the lower slope of the latter ridge. It is bordered on the west by the valley of the Aire River. This valley is narrow from Varennes to Grandpré, but north of the Grandpré a similar but broader lowland extends northward to the pass east of Attigny. East of the Aire valley, the country is a rolling plateau drained by streams which flow west to Aire

River in rather broad, smooth valleys, and by streams which flow eastward to Meuse River in narrower, steeper valleys and ravines. The interstream areas are broad and smooth, and rise to similar elevations except for isolated hills or groups of hills which stand as knobs on the generally smooth upland. Such knobs are the hills at Vauquois and Montfaucon and the clump of hills southwest of Romagne-sous-Montfaucon. The woods are usually located on the divides and isolated hills. Offensive operations in such a country consist in the taking of one east-west ridge after another. Possession of the wooded ridge crests and the isolated hills gives the best observation posts and largest field of fire. That these features are thoroughly appreciated by the enemy may be seen in the skill with which the Kriemhilde Stellung has been located so as to take full advantage of this topography.

The Woevre Plain, underlain by soft and impervious shales, has two primary characteristics: It is very flat, and very muddy in wet weather. The plain, however, narrows rapidly north of Verdun, and from Stenay northward gradually disappears in the gently-rolling country of the pass of the Sedan. Once the Côte de Meuse is completely held, the Woevre Plain forms no obstacle to an advance into Sedan.

The pass of Sedan lies between the ridges previously mentioned and the rough mountainous country called the Ardennes. Traffic from the east follows the valley of la Chiers River. West of Sedan the Canal d'Ardennes runs southwestward up the valley of la Bar River, and then over a low divide to the Aisne River at Attigny. The pass of Sedan, comprising the valley of the Meuse from Sedan to Mezières, is the route along which runs the main line railroad Metz-Conflans-Longuyon-Montmedy-Sedan-Mezières. This portion of the railroad is the central section of the great "ligne de rocade" which parallels the German front in the west, and over which troops are shifted laterally along the line. The cutting of this line at Sedan is topographically practicable once the Forêt d'Argonne and the Côte de Meuse are held.

The Attack of November 1, 1918

From October 8 to October 16 our Corps was occupied with the slow and painful assault on the Kriemhilde Stellung, which ran among the wooded hills southwest of Romagne-sous-Montfaucon. This German defense position had been provided with wire but the trenches had only been marked out and not dug to

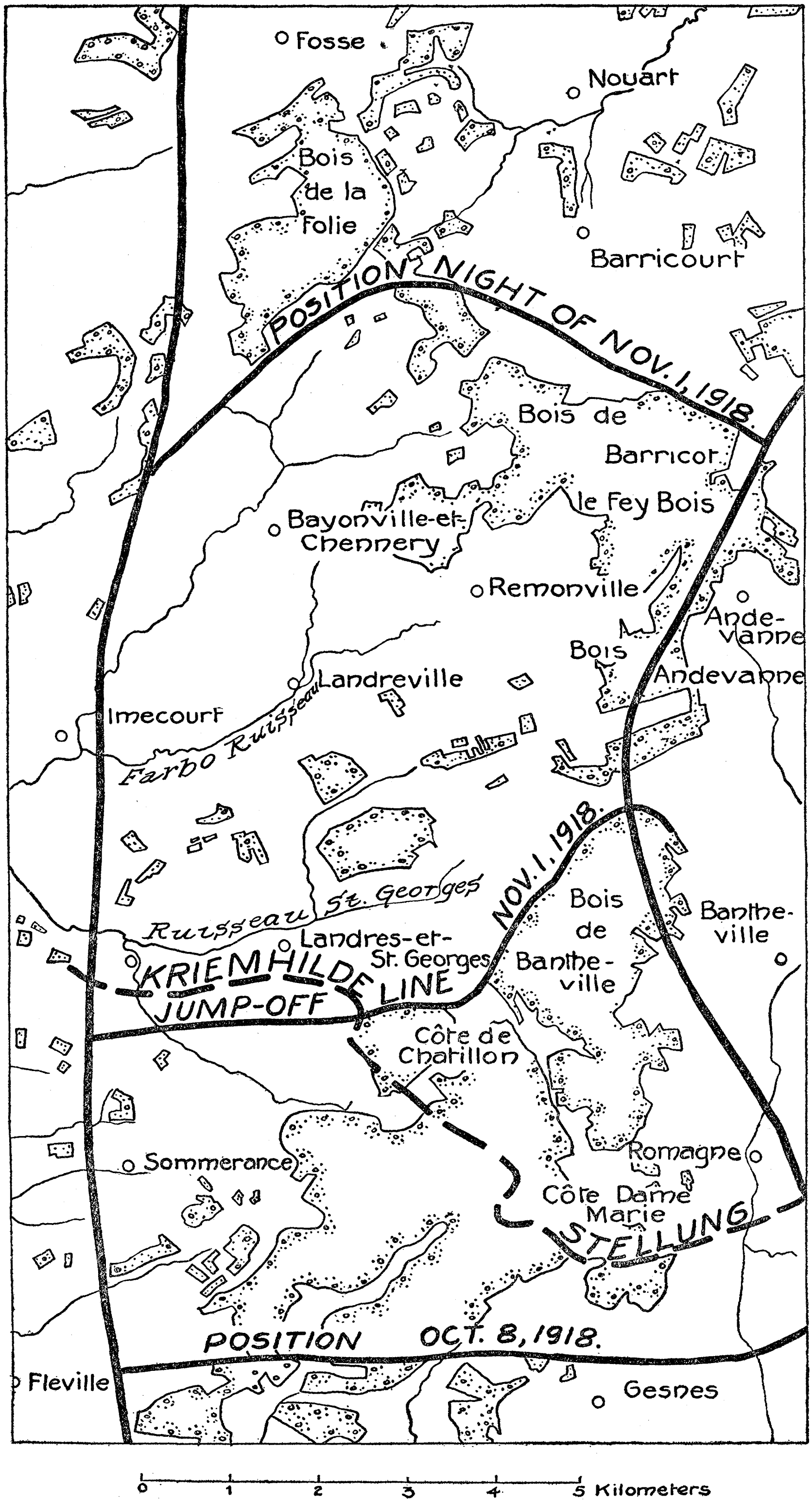

FIG. 2. ZONE OF ADVANCE OF THE 5TH ARMY CORPS IN THE ATTACK OF NOVEMBER 1, 1918.

the full depth. The Kriemhilde Stellung was then not a complete trench system but a previously selected retirement position which was rather hastily converted into a deep zone of machine gun positions and rendered very serviceable because the high hills gave good observation of our preparations for attack. Wood by wood, and hill by hill, these positions were gradually taken. By October 21, our Corps front lay in front of the wire south of Landres-et-St. Georges and thence swung northeast along the border of the Bois de Bantheville. The local and general situation being ripe, a general assault was ordered for the morning of November 1, 1918. For this successful attack most elaborate preparations were made and the maps produced by G–2, 5th Army Corps, are so complete and well designed that they are likely to become a classic example of good practice.

On the evening of October 30, Lieutenant Holmes gave me orders to prepare a report on the streams which lay in front of our positions, and which might prove an obstacle to our advance. There was no information available regarding these streams except that shown on the Plan Directeur, a map compiled by the French on the scale 1:20,000. The Water Supply Report on the area issued by the Chief Engineer gave no particulars of these minor streams. However, this seemed to be an opportunity to describe the valleys even if there was no information about the streams. The area to be covered, shown in Figure 2, lay between our jump-off line in front of Landres-et-St. Georges and the objective line along the crest of the Côte de Meuse west of Barricourt. It is 6 kilometers (5 miles) wide, and has an area of 44 square kilometers. The topographic description of a small area is difficult enough, and particularly so when direct observation can not be made. The remarks on the convexity of valley walls and on the importance of gullies were due to observations around Cheppy, and are probably the most valuable part of the paper.

With good maps on the scale of 1:20,000, and opportunity to view the country from a balloon, descriptions of this type would be rather easy to prepare. They should be useful to infantry officers to explain the maps which are now commonly furnished to them with orders to attack. Later, the same description would furnish material to the Corps Press Officer for the daily description of the terrain which he furnishes to correspondents.

MEMORANDUM OF THE WATER COURSES AND VALLEYS OF THE ZONE OF ADVANCE OF THE 5TH ARMY CORPS

The zone of advance of the 5th Army Corps lies on the western slope of the Côte de Meuse. This striking geographical feature is a ridge which has a very steep eastern slope and a gentle western slope. It extends north as far as Verdun, and thence northwesterly, dying out in a series of low hills in the vicinity of La Chesne. The sinuous valley of the Meuse River breaks the continuity of the ridge east of the Corps Area, while the valley of la Bar River, extending from the lowlands near Buzancy north to Sedan, marks approximately its northern boundary.

The streams which drain the Côte de Meuse flow northeast and east to the Woevre Plain and Meuse River and southwest to the Aire River from a broad divide. The streams which flow northeasterly lie in sharp, steep-sided canyons and divide the eastern border of the Côte de Meuse into a series of ridges which extend like stubby fingers into the Woevre plain. The southwesterly streams are longer, have wider valleys and gentler gradients.

The divide between these two stream systems is usually flat, and from ½ to 1 kilometer wide, and generally wooded. South of Bantheville the divide lies west of the crest of the ridge; north of this point the stream divide swings northwestward and corresponds to the crest of the Côte de Meuse. In a general view only the gentle westward slope of the plateau is visible. The stream valleys are concealed. The drainage divide is only a part of the general plateau surface which slopes gently west and southwest. Occasional knobs, such as the Côte Dame Marie and the Garenne de Moulin, rise above the general level. Such knobs are usually located on the divide. Because of their steep and wooded slopes the enemy uses these knobs as strong points. They have also high value as sites for observation posts. Military operations along the wooded divide are difficult, but the history of fighting in the Bois de Gesnes, Bois de Romagne, and Bois de Chauvignon show that the divide once attained commands the lateral valleys. North of the present line the divide is marked by Bois d'Andevanne, le Fey Bois, and Bois de la Folie.

Since the eastern boundary of the Corps Area runs along the drainage divide as far as le Fey Bois, the right division will have no running water to cross except on its extreme left wing. The upper parts of Ruisseau St. Georges, and Ruisseau de l'Agron are very small streams, and present no obstacles. The left division will cross both streams with its whole front. These streams are shallow brooks easily waded except in very wet weather. Like all the streams of the region, however, the brooks are lined with trees and bushes, and these furnish natural concealment to small bodies of men. North of Imecourt an unnamed stream flows diagonally across the field of action of the left division. It is, however, no larger than those previously mentioned, and it should be possible to cross freely from one side to the other. The bushes and trees along its banks will furnish some cover in the valley, otherwise easily commanded by fire from an enemy stationed near Bayonville et Chennery.

The succession of stream valleys which one after another cross the Corps Area present much more serious obstacles than the streams which flow in them. A brief description is therefore given. There are three important valleys: (1) The valley of Ruisseau St. Georges; (2) Valley of Ruisseau de l'Agron; (3) Valley of the unnamed stream flowing from Bayonville et Chennery to Imecourt. Each of these valleys is about 1 kilometer wide. The slopes are gentle, cleared and cultivated. The slope of the valley walls is, however, convex upward, *i.e.*, the upper part of the slope is gentle, the lower part steep. Thus it is necessary, in most cases, for an observer to come part way down the slope to see the bottom of the valley, and, vice versa, an observer in the bottom of the valley can rarely see the crest. The importance of this dead ground is obvious.

In general, the tributary valleys are mere crenulations on the valley walls, and consequently of little value. In each of the three valleys there is, however, an important exception.

In St. Georges Valley, at the town of Landres-et-St. Georges, and extending due north for a kilometer, and thence to and beyond Ferme la Bergerie, is a deep ravine. In this ravine is an enemy narrow-gauge railway. Once the heights on either side are taken, this ravine affords ready communication, free of enemy observation, to the heights dominating the valley of Ruisseau de l'Agron.

From the valley of Ruisseau de l'Agron the ravine of Farbo Ruisseau extends about 1½ km. north of Landreville. It is approximately parallel to the valley from Imecourt to Bayonville et Chennery; consequently, from the region of Imecourt and Landreville to the north our left division will be progressing with the grain of the country instead of against it. This sudden change in terrain will have proportionate effect.

The valley of the unnamed stream from Imecourt to Bayonville is not essentially unlike the others. North of Bayonville et Chennery, however, it forks almost at right angles. A third ravine gives the head of this valley a fanlike arrangement of ravines. Once Bayonville is held these ravines offer excellent lines of approach against the heights from Barricot Bois to Bois de la Folie.

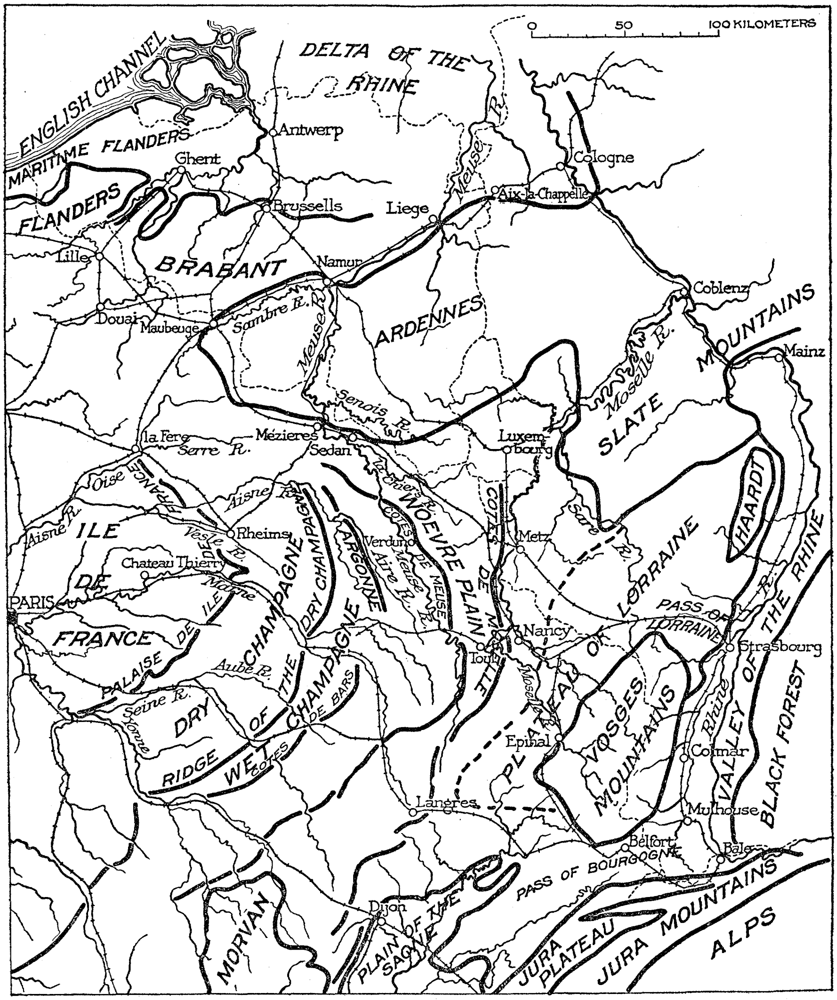

FIG. 3. MAP OF THE MAIN RAILROADS AND PHYSIOGRAPHIC PROVINCES OF THE EASTERN FRONTIER OF FRANCE.

While in general the valley walls are smooth, and the valley bottoms are grassy meadows, there are a few narrow, steep-banked gullies. These gullies are from 5 to 15 feet deep, from 10 to 50 feet broad, and from $1/16$ to $3/4$ of a mile long. The gullies seem to be recent in origin and due to concentration of flood waters since the clearing of the original forests. Each gully forms a natural trench with a natural camouflage of overarching bushes. The Germans use the gullies very cleverly for machine-gun positions, artillery positions and dugouts.

Map of the Physiographic Province of Northeastern France

About the middle of October the need of a map of northeastern France on a sufficiently small scale to be studied readily when held in the hand seemed plain though no maps of this type were furnished us. Our officers were continually handicapped by the necessity of handling large maps crammed with detail of little significance for the major problems. Captain (then First Lieutenant) Thomas H. Thomas, Officer in charge of Enemy Order of Battle, requested Lieutenant Holmes to have me compile a map to show the main railway lines of northeastern France. This opportunity enabled me to make such a map and one that could also be used to show the location of the physiographic provinces. The map was made by tracing and piecing together the small maps on the scale: 1:2,000,000 which appear in the Atlas Classique de France, by Schader & Galleuedec to which reference has already been made.

The completion of this map was delayed by my being assigned to the advance echelon at Cheppy, but the lithograph was completed by November 5. While the lithographers were at work a tracing of the physiographic provinces was made in blue hectograph ink. By use of the jelly roll the boundaries of the provinces were over-printed on the black lithograph in blue. This map excited much interest among our officers, and with and without the overprint it would have been very useful if operations had continued. It is reproduced in Figure 3, redrawn so as to be reproduced in one color and to eliminate some of the crudities of the original.

Value of the Work.

To estimate the value of Intelligence Work is difficult enough, and one can not be sure that any of these efforts had any value in the final result. However, the following quotation from Colonel Russell's report on the work of G–2, 5th Army Corps in the Meuse-Argonne is typical of his generous attitude:

> Among the draughtsmen of the Topographical Section was an expert geologist, who prepared an excellent study on "The Military Topography of the Argonne Region," "A Memorandum on the Water Courses and Valleys of the Zone of Advance of the 5th Army Corps," and a "Map

of the Physiographic Provinces of the Eastern Frontier of France." This work is normally beyond the scope undertaken by the Corps, and falls more naturally under Army activities, but Private Kirk Bryan (now Second-Lieutenant Engineers) prepared the studies on his own initiative, and they were too good not to be published.[3]

PART II. SUGGESTIONS FOR THE USE OF PHYSIOGRAPHY IN THE ARMY

Reports on Topography

In the foregoing sections, the use in military operations of studies of topography has been illustrated. Many other examples could doubtless be culled from the Intelligence reports of the various armies engaged in the Great War. Future studies of this kind will fall naturally into two groups: (1) studies of large areas; (2) studies of areas of moderate or small size. Studies of large areas will partake of the general character of the report on the Argonne Region and the map of the physiographic provinces of northeastern France. Work of this type will be undertaken as a basis for strategical plans and study, or for the general information of officers and troops. It is naturally a duty of the staff of an army or the higher command in a campaign involving more than one army. Moderate-sized areas will ordinarily be involved in the sphere of an army corps. The problems will be tactical, but the occasions for making the studies may be of different sorts. In the example given in preceding pages the object was to describe a small area for the information of troops immediately before an attack. It is conceivable, however, that a detailed description illustrated by block diagrams and profiles would be of great value in solving the tactical problems of the slow reduction of an enemy position. The complicated topography of the Côte Dame Marie and adjacent hills would have furnished a fit subject for such a study.

Genetic Study of Land Forms

It is well recognized among physiographers and geographers that a complete understanding of land forms, that is, topography, can only be gained and remembered by a study of the origin of these forms. This study of genesis has led to the conception of the earth's surface as a series of repeating patterns, the patterns being identical where like rocks have been subjected to like conditions for equal times. Davis has summed up this condition in the dictum: Form equals structure plus process plus stage. As a result of the application of this dictum, the trained physiographer has a classification of hills, of valleys, of shore lines, etc., imperfect enough, but sufficiently exact so that a single term calls up to his mind solid objects very complex in form, and frequently difficult to describe as individual or abstract units.

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[3] Russell, Geo. M., Colonel G. S., Assistant Chief of Staff, G–2, Report of the Second Section, G. S., 5th Army Corps, U. S., Jan. 27, 1919. Intelligence Section, 5th Corps in Meuse-Argonne Operations, Ms. p. 22.

Just as he has classified single land forms, so he has divided the earth's surface into tracts of country having similar land forms or similar diversification of topography. By means of these divisions he has simplified the task of learning the characteristics of the topography of whole continents. Thus, both systematic physiography and descriptive physiography are a necessary part of the training of a professional soldier, for concise statements defining the character of the terrain form the basis for tactics and strategy. To the thoroughly trained officer operating in a region with which he is familiar, knowledge of the terrain comes easily, as part of his daily observation and map study. He hardly realizes what a large rôle it plays as a background for his thought, nor the difficulty which other men may have in acquiring the same knowledge. Thus the French had no geological officers, for a knowledge of French geology and physiography is a part of the training of every educated Frenchman, and many of their permanent officers are amateur geologists.

The American Expeditionary Force, operating in a strange country, with officers the bulk of whom were but recently civilians, needed an adequate system to supply information regarding topography, geography and geology. For engineer units, the geologic section of the Chief Engineer's Office, G. H. Q., under Lieutenant Colonel Alfred H. Brooks, supplied geologic information in a satisfactory manner. There was, however, no organized attempt to supply the army with predigested topographic information.

Peace-time Conditions

In peace time the courses in physiography in military colleges should be strengthened, and colleges which maintain a Reserve Officers' Training Corps, should make courses in physiography compulsory for men enlisted in the Corps The courses should be complete and thorough, but no special military flavor is necessary. An American army officer, even with his frequent transfers, can not be personally familiar with so great a country as the United States. Our possessions are also quite extensive and widely scattered. The regular army officer, on transfer to a new post, should be able to quickly search out, read and understand the available physiographic literature. He will thus most rapidly obtain that grasp of the terrain which will make his military knowledge and ability most useful.

The physiographic studies of large areas here advocated will become a part of the Monographs of Military Intelligence now published by the General Staff of the Army. The studies of smaller areas will be useful in the preparation of the Zone Handbooks of the same organization.

Use of Physiographic Material in Training Periods

Knowledge along physiographic lines is rapidly being advanced. No artificial stimulus seems necessary, but areas of particular military value might be put on a preferred list by State and National Surveys. At the present time fuller knowledge of the Mexican border would be of great potential value. Prior to the outbreak of war, however, special pamphlets giving a brief but comprehensive description of the theater or probable theaters of war should be prepared from the constantly increasing body of physiographic literature. These pamphlets might well be prepared, at the request of the Army, by the United States Geological Survey. Such a plan was already on foot at the close of the war and abandoned because of the armistice. These pamphlets should be distributed to all officers and officer candidates. Judging by the popularity of D. W. Johnson's "Topography and Strategy of the War," such pamphlets would be eagerly read and studied.

As a stimulus to map reading and to the acquirements of the art of observation, short descriptions of cantonment and billeting areas are useful. These should contain simplified physiographic and geographic descriptions with accounts of local points of historic and scenic interest. They should be longer, but similar in character to the descriptions which were prepared during the late war, and printed on the backs of topographic maps of cantonment areas. Since these pamphlets would be simple compilations of existing material, and of no special value to the enemy, they should be available to all ranks.

Personnel in Active Operations

At the outbreak of war, a suitable group of geologists should be chosen for duty with the Army. It is obvious that they should not be too old, nor more valuable at home because of expert knowledge of war minerals. The ranking officers should, however, be men of maturity and sound judgment. All the geologists in the Army should be responsible to a single officer for the technical side of their work. The geologic work done to determine suitable locations for dugouts may be equally valuable in solving a question in water supply; also, the same books and maps are necessary in preparing physiographic studies as in locating well drained sites for camps and hospitals.

Geologists with special aptitude for physiographic work while remaining under technical supervision of the Chief Geologist should be detailed to the Intelligence Section. To these officers will fall the work of preparing studies of the topography for the information of officers responsible for operations. These studies will then fall in line with other studies prepared in the Intelligence Section (G–2), and can be circulated in the same fashion.

Duties of Officers Assigned to Intelligence Section

The studies instituted by geological officers with G–2 will be of two types: (1) confidential reports to the higher command in advance of decisions, (2) general reports to lower units after decision.

Confidential reports will be dependent, for their effectiveness on the good judgment of the geologist, and he should be specially selected and of the highest caliber. He must have and retain the confidence of responsible officers, and for the best results he should have relatively high rank and should be assigned to, or be a member of the General Staff.

After decisions have been made as to the field of operations, or for offensives in large areas, reports should be sent out from Army Headquarters describing the topography, geology and other features of the terrain. These reports should be of a general character, somewhat similar to the "Military topography of the Argonne Region," but longer and with more detail. These reports should be illustrated by special maps, diagrams, and photographs, and so designed as to excite interest and to stimulate thought and observation in officers of the lower echelons. These general reports may well be followed later by special memoranda commenting on certain features of the landscape which experience has shown to have particular military importance. The illustrations for the reports will tax the ingenuity of their author, since the material should be presented in as graphic and pictorial a manner as possible.

When an offensive involving a corps or army front has been decided on, the geological officers should prepare special reports for each corps on the topography of the zone of advance. These reports should be circulated with orders to attack. They should be so written that they do not imply definite boundaries to the corps zone of advance, or define the objective, else by falling into the hands of the enemy early in the attack they give him useful knowledge. With this proviso they should be circulated down to platoon commanders. These men, in particular, should have their imagination stimulated, and visualization of the map made easy by a written description. Necessarily, they will have had less technical training than officers of higher rank, yet the platoon commanders must first penetrate into the new country. In the late war many platoon commanders went forward for five or six kilometers, with no map and no information but the order to follow a certain compass direction. A small-sized sketch map and a written description of the country are certainly not too much to give them.

The preparation of these descriptions will probably be the most difficult task of those outlined in this paper. The areas will be small. In many instances, the hills, valleys, and streams have no local names. The differences between adjacent hills may be very slight and difficult to describe. Also the audience addressed will contain men of all degrees of education with very diverse civilian occupations, and of many temperaments. All these men will be tired, worn with anxiety, restless from excitement, and many of them hungry. They will be compelled to read the statement under all conceivable conditions of discomfort and danger. It should then be short, simple, but vividly worded, and should drive home important points by repetition of simple phrases.

These descriptions for the attack should be rewritten for the Press Officers of each Corps. It is the duty of these officers to furnish daily to war correspondents a description of the country in which fighting occurs. They are usually newspaper men, and will quickly absorb and make popular the phrases which the geologist-physiographer applies to the topography. Such work has its reflex action, since an American army, from general to private, reads the daily communiqués and the accounts of war correspondents at every opportunity. If the topographic descriptions in these accounts are good then the whole army is educated, and official descriptions such as have been advocated will have proportionately greater effect.

Facilities for Geological Officers

The geological officers performing the functions outlined above will require a small working library. Through the Chief Geologist they will obtain geologic maps and reports prepared for engineering purposes. They should also have access to the maps printed and prepared by the Intelligence Section (G–2–C). They should have the complete confidence of the Intelligence Section of the unit to which they are attached, and should have the right to have special maps and diagrams prepared by this organization through which also their reports will be circulated.

Field work along the firing line will often be necessary, and the geologists should have frequent conferences with line officers of all grades. Admission to observation posts of all types should be granted them for the purpose of viewing the enemy territory. Occasional use of observation balloons and even aeroplanes may also be necessary.